Globalisation, Alimentation and Human Diversity

Macbeth, Helen
Oxford Brookes Univ. School of Sciences and Law. Anthropology Dept. Gipsy Lane. Headington. Oxford OX3 0BP
hmacbeth@brookes.ac.uk

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En el ámbito global, la diversidad biológica humana existe dentro de las poblaciones y a través de ellas. La diversidad se produce a través de la interacción compleja de muchos procesos, incluida la nutrición. La globalización de las comidas y de los hábitos alimenticios se ha producido ya en la prehistoria y en la historia y continúa produciéndose con rapidez en la actualidad, ocasionando cambios nutricionales. Estos cambios afectan la salud de distintas personas de forma diferente. Este trabajo destaca la diversidad de los efectos sobre la salud y centra su interés en las causas evolutivas.

Palabras Clave: Alimentación. Globalización. Diversidad humana. Nutrición. Enfermedad. Migración. Genética. Multidisciplinaridad.

Eremu globalean, giza dibertsitate biologikoa dago bai populazioen barnean bai horien artean ere. Prozesu askoren eragin-trukearen ondorioz gertatzen da aniztasun hori, nutrizioa horien artean. Janarien eta elikadura ohituren globalizazioa jadanik gertatua da historiaurrean eta historian zehar eta gaur egun ere bizkor gertatzen jarraitzen du, nutrizio aldaketak dakartzala. Aldaketa horiek era desberdinean eragiten die pertsona desberdinen osasunari. Lan honek osasunaren gaineko eraginen aniztasuna nabarmentzen du eta kausa ebolutiboetan jartzen du arreta.

Giltza-Hitzak: Elikatzea. Globalizazioa. Giza dibertsitatea. Nutrizioa. Gaixotasuna. Migrazioa. Genetika. Diziplina aniztasuna.

Dans le milieu global, la diversité biologique humaine existe au sein et à travers les populations. La diversité se produit à travers l'interaction complexe de nombreux processus, y compris la nutrition. La globalisation des repas et les habitudes alimentaires existaient déjà dans la préhistoire et dans l'histoire et continue à se produire rapidement encore actuellement, occasionnant des changements nutritionnels. Ces changements affectent la santé de différentes personnes d'une façon singulière. Ce travail fait ressortir la diversité des effets sur la santé et centre son intérêt sur les causes évolutives.

Mots-Clés : Alimentation. Globalisation. Diversité humaine. Nutrition. Maladie. Migration. Génétique. Multidisciplinarité.

1. INTRODUCTION

To understand human biological diversity one has to bear in mind many factors and in research it is important to insist on the necessity for a multidisciplinary approach to understanding these factors. Among these factors is nutrition. Many perspectives and disciplines are also involved in the study of nutrition and food habits.

In this paper I shall make several points about globalisation, human biological diversity and human food. After some relevant autobiography regarding population genetics, I shall talk of the effects of the global dissemination of some foods, some food technologies and some food habits, bearing in mind human diversity. My paper will cover a broad canvas with some simple explanations of the genetics.

2. HUMAN BIOLOGICAL DIVERSITY

As a biological anthropologist, at the centre of all my first research studies were the logic and the models of population genetics and human diversity. I suppose that my special contribution was to remind people that we, humans, are not fruit flies or moths, but that we take personal and conscious decisions based on social, cultural, economic and geographic conditions and status. These decisions affect the models of human genetics (Macbeth, 1985). Thus, my intention was to integrate perspectives from the social sciences into the models of genetics. Later I began to concentrate on alimentation so that now I prefer to be considered a biosocial anthropologist.

In regard to population genetics, I concentrated on migration and why people moved home, for short or long distances (Macbeth, 1984); and I tried to integrate such variables into the models of gene flow, both random and non-random, which in the 1960s and 1970s had most frequently been based on nonhuman species (e.g. Mettler and Gregg, 1969). This is relevant to this paper because globalisation occurs through the many migrations of people and goods across the whole world. The basic genetics model is that with isolation the gene frequencies of populations tend to diverge through the processes of mutation, natural selection and factors involved in genetic drift (Dobzhansky, 1962; Cavalli-Sforza and Bodmer, 1971; Gould, 2002), but the majority of migrations of fertile individuals increases the similarity of the gene frequencies of the donor and recipient populations (Cavalli-Sforza and Bodmer, 1971). That is the basic model, but by including the cultural and socioeconomic factors and the richness of human individual decisions, the patterns may diverge from that basic model; for example, the situation is more complicated when the migrations are not random (Hiorns, 1984). Through socioeconomic studies, we know that individual or group migrations of humans tend to be intentional, either through the decisions of the migrants or through social, economic, political or military pressures on them; so, those who migrate are not likely to be random samples of the population they leave (Rossi, 1955; Macbeth, 1984).

There have always been human migrations of short or long distances. A simple example is that if siblings avoid marrying each other, then one or other of every couple must have moved at least out of the parental home. That already causes gene flow and some might have to travel far to find a partner of the opposite sex of the appropriate age. Movements of short distance are frequently ignored in our concepts of 'migration' but they are enormously relevant to global gene flow.

So, while over the whole length of human evolution there have globally been so many different patterns of partial isolation of groups, either by distance, geographic barrier or social preferences, that biological diversity does indeed exist, yet migration (either by groups or by individuals) has always resulted in some gene flow (Macbeth; et al., 1996). Thus, human diversity exists, but the consequence of constant gene flow is that we remain one species, *Homo sapiens*.

The huge Human Genome Project over the whole world has shown genetic diversity within every population, and also has shown diversity in gene frequencies across spatial distances. It also demonstrated clearly, as shown by Brace (1964) more simply earlier, that along those distances, the gene frequencies diverged gradually in so-called *genoclines*, only slightly disturbed at barriers, whether physical, political or language (Barbujani and Sokal, 1990) boundaries occurred. Therefore, the concept of 'Human races' as separate genetic groups has no basis in biological reality. These genoclines have been maintained through migrations of short distance, without drama, of daily life, counteracting, but not obliterating, any forces of natural selection in differing ecological settings, even where the differentiation seems small.

In the last five centuries, global explorations and travels have covered spectacular distances. Thus, we learned of the global diversity of human populations. Since then many humans have settled in continents far from their birthplace or place of their ancestors, and everywhere this has caused some genetic admixture, which also demonstrated the unity of the human species. Even back in the 1970s, Harris (1975) was able to show that the genetic diversity within each population is now so great as to exceed the diversity between populations.

A summary of the global situation for human biological diversity, with an emphasis on genes has been given above, but an important fact relevant to the rest of my paper has not yet been emphasised sufficiently. The result of natural selection is indeed shown in the gene frequencies (Fisher, 1930), but natural selection works through the rates of survival and reproduction of adult individuals. There are many non-genetic factors that interact with genes in forming the total biology of individuals for their survival to adulthood and their subsequent parenthood. One of these non-genetic, but indeed biological, factors is nutrition, not only in quantity but also in quality.

Nutrition, as other factors, depends not only on the physical environment in each place, but also on the whole diversity of technological and cultural

patterns in each society in each period of time. We know, as is explained in several papers in this volume, that nutrition affects body shape, size and health during an individual's life, but the nutrition of generations can also be relevant to evolutionary factors, and thus to human diversity. It is important also to understand that the selectors in natural selection are not due solely to the physical environment, but also to the technology, the culture and the economics of the society in which each individual lives. The processes of natural selection have not disappeared with modern technology, but the new technological conditions are simply part of our contemporary environments. The survival of the word 'natural' in Darwin's theory of 'natural selection' has sometimes been misleading to those trying to understand the processes for the first time.

3. GLOBALISATION OF ALIMENTATION

I shall start with climate change and global warming, but not the global warming of today. I refer to the global warming of some ten to eleven thousand years ago, when the glaciation of some latitudes melted, and the sea level rose all over the world. At about this time and later, apparently quite independently in various parts of the world, some humans started to manage the reproductive cycles of some plants and some animals; they began the technologies of agriculture!

Until then and during a large part of their biological evolution, humans and their ancestors had fed themselves through foraging and hunting. Nevertheless, in the context of this paper, it is important to remember that what can be gathered and hunted in different ecosystems does vary (Jenike, 2001). Thus, even in the long eras of hunting and gathering, human food varied geographically. Even in the twentieth century Polly Wiessner (1982) identified very local differences in the foods of groups of San bushmen in the Kalahari desert.

Although we know that hunting and gathering has continued in some rare societies until recent times, we can see evidence of the globalisation of agricultural ways of life in archaeological and historical material. This was a food technology that had dramatic effects on human nutrition (Diamond, 2002; Larsen, 2002). For example, it gradually involved more carbohydrates, less fibre, more saturated fatty acids in domestic animals than in wild animals, and in due course in dairy foods, and other such changes. However, another very important difference was that it also incurred a new seasonality to nutrition, with periods of plenty and periods of little, due to the different annual cycles of climates, the agricultural ways of life and the sedentary requirements for cultivators (e.g. Stini, 1988).

Thus, I argue in this paper that we should consider the topic of 'globalisation and alimentation' in prehistoric, historic and modern situations. The principal prehistoric perspective is the global transition towards agriculture.

We have sporadic information on different ethnic diets throughout history, but generally we do not know how persistent or mutable they were. What is more, we often do not know how uniform they were for all the people in such populations, although one might presume that some form of unequal distribution according to different ranking systems was common. We also tend to think of traditional diets in societies of simple technology as having remained unchanged for generations, but the proofs of this are insufficient. Each historic piece of evidence is only an instantaneous photo of that moment in time. Some changes will have taken place with the passage of time, about which no evidence, either archaeological or historical, remains. We do know something about global differences in cultivated foods with the use of different domesticated species of the family of the grasses dominating as principal carbohydrates. Historically, wheat, oats and barley were generally eaten in Europe, maize in many parts of the Americas, millet and sorghum in parts of Africa, etc. Meanwhile in other regions they cultivated various root vegetables as their main carbohydrates (Harrison; et al., 1988). Domestication of animal species also varied in time and place. Kretchmer (1993) describes significant geographic differences in the spread of pastoralism and milk consumption, starting in the fertile crescent and passing in quite early post-agrarian times to Europe. This summary is a simple generalisation of a situation which was much more complex, due to ecological and cultural differences even between coastal and mountain locations in the same general region, with microdifferences in culture and history, and of course in prosperity. Thus, even this brief generalisation shows the existence of local diversity in alimentation from small-scale to global.

Despite such diversity in alimentation, foods and condiments have always been traded along short or long distances. For example, the search for a maritime route for oriental spices stimulated the era of the great European explorations of the fifteenth and sixteenth centuries. Since then more distant foods have been brought back to Europe and from then onwards Europeans colonised lands throughout the world and introduced their European agricultural methods and products wherever climates allowed. I shall give no more data on this – I only want to make the observation that alimentary diversity existed and nutrition affects the biology of humans and even their biological evolution. An important detail is that new food products can affect different humans in different ways, and thus their individual chances of survival and reproduction. In this way, a totally changed diet in a society, a population or a region can provoke evolutionary changes in human biology in that locality.

4. ALIMENTATION AND GLOBALISATION IN MODERN TIMES

Many interesting perspectives on alimentary globalisation in recent and modern times are brought together in this volume. However, I should like to divide my comments on this into four parts:

4.1. Travel, tourism and ethnic restaurants

With travel and tourism, and with the popularity of restaurants of non-local ethnicities, some tastes have been changing. What is more with so-called 'ethnic' or 'locality' cookery books even home cooking has been changing in many households. All this can produce biological effects, but please remember that there are big differences today between individual households and between persons, even in the same city street, in what they consume at home.

4.2. The movement of raw foods

Above I referred to seasonal availability of foods with the transition to agriculture. With modern methods of transport, refrigeration and freezing, this situation has changed. Not only, in our northern latitude societies, are our seasonal fresh foods now available all year around, but also in the supermarkets we can find a large and exotic variety of tropical foods from Malaysian prawns to African pineapples. For those who can pay, seasonality of fresh foods need no longer cause any seasonality in nutrition. Again, this provides a potential for biological change.

4.3. Globalisation of industrially produced foods

I turn now to the global spread of food products which have been industrially modified, prepared and produced. I do not need to go into details (McDonalisation, Coca-Colanisation, etc.) as there are other references to these in this volume. The ingredients of these modern industrial products are complex, little understood by the majority of their consumers, and, where they are written on the labels, they are hard to comprehend. Without understanding these ingredients, one cannot judge their nutritive values and their biological consequences, but there will certainly be some consequences.

4.4. Carbon emissions and the transport of foods

A subject not covered elsewhere in this volume, but which, we can presume, is likely one day to affect the total biological environment and human biology, is that of carbon emissions and contemporary global warming. We have an expression in English, 'food miles', which I gather is not easily translated into other languages. The concept of 'food miles' draws attention to the carbon emissions of vehicles which transport foods around the world. The resulting recommendation is 'Buy locally produced foods'. There is a flaw in this argument because many local foods in the cooler latitudes are seasonal and when they are locally produced out of their natural season, they require artificial heating and/or light for growth. So, to illustrate a point, let me just compare two scenarios which keep British supermarkets stocked with fresh vegetables all year around.

1. Green beans, cultivated in Kenya, are in the British supermarkets all year. They are cultivated in open air with natural solar light and heat and they provide useful local employment. They are, I'm told, transported on regular passenger flights to Europe, not on specific cargo flights.

2. On the other hand, for example in Holland, seasonal salads and green vegetables as well as vegetables native to hot climates are cultivated even through the winter months under glass and with strong, electric lights and heating.

It is relevant to the issue of carbon emissions to compare these two scenarios, and other situations, holistically as regards their total carbon emissions during production as well as in transport. There is, of course, much more to consider on this topic, which merits a whole chapter, and has been discussed elsewhere (e.g. MacGregor and Vorley, 2006; Heyes and Smith, 2008; Sirieix; et al., 2008; Edward-Jones; et al., 2008; Garside; et al., 2009).

5. FOOD GLOBALISATION AND HUMAN POPULATION DIVERSITY

Continuing in this same style of a panoramic or broad vision, this paper will now consider how globalisation of foods has affected the biology of different human populations.

In the 1970s and 1980s, Boyden (e.g. 1987) drew academic attention to the biological impact of the foods of so-called 'western civilisation' on humans. Since then many investigators have added to the literature on this topic (e.g. Larsen, 2003), and a recent example is a paper by Cordain et al. (2005), whose thesis, very much reflecting that of Boyden's, is that human beings had adapted biologically and genetically to their hunter-gatherer past without having had evolutionary time to adapt to the important changes in diet brought about by globalisation –first of agriculture– and now of industrially processed foods. Cordain et al. draw attention to a list of food types found in a typical 'Western' diet, but not available prior to agriculture: the meat and dairy products of domesticated animals, cereal grains, refined sugars, refined vegetable oils, alcohol and added salt, which they link to a higher intake of saturated fatty acids, more carbohydrates compared to proteins, more salt and a higher glycaemic load. They argue that this affects the patterns of the so-called 'diseases of civilization', obesity, cardiovascular diseases, type 2 diabetes, several cancers and osteoporosis. One can, of course, add greater detail to this list, but it is worth noting that the illnesses mentioned by Cordain et al. (2005) are generally enfeebling or fatal in middle age or later, and in many cases would not have affected the rates of procreation, and thus evolution. The debates on the possible evolutionary effects of post-agrarian diets are many (e.g. Larson, 2003; Lieberman, 2003).

Meanwhile, Neel (1962, 1982) had published his hypothesis of the 'thrifty' genotype in relation to type 2 diabetes and related obesity. The idea was that there exists a genotype which allows the storage of fat when there

are sufficient foods, and this fat links to insulin release and survival during periods of severe hunger and famine. Without periods of severe hunger, for example in modern conditions of ample food in many modern societies, this genotype can result in obesity, sometimes morbid, and type 2 diabetes. There are other explanations for the selective advantage of such a genotype; for example, the advantages of the fatness levels of the infant or its mother (e.g. Wells, 2003) in times of food scarcity. Again, I leave the reader to pursue the topic more fully elsewhere. What is interesting in regard to this paper is that obesity is hardly ever found in modern hunter-gatherers, neither is extremely severe hunger. Their normal condition of life is limited nutrition but constant. Thus, one might suggest that it was the seasonality and the insecurity of primitive agriculture which provided the selective advantage in times of famine for those who had stored fat, rather than any selection during pre-agrarian populations of hunter-gatherers. That would mean evolution post-agriculture and would shift the emphasis of the hypothesis of Cordain; et al. (2005). Southam; et al. (2009) studied DNA sequences in individuals prone to type 2 diabetes and/or obesity and found some evidence for selection of certain genes, but not sufficient for a clear confirmation of Neel's hypothesis of a 'thrifty' genotype.

Another example that alimentation must have caused an evolutionary change after the spread of agriculture is the global distribution of the intolerance of lactose beyond infancy (Kretchmer, 1993; McMichael, 2001). More than half of adult humans around the world cannot digest fresh raw milk because the lactase production of their infancy disappears in later childhood. Yet, others retain their production of lactase which enables them to break down and digest lactose. The distribution is irregular both geographically and ethnically. There is a genetic basis to this, with specific genes identified, and there is also a link with discontinuity of milk consumption after infancy. The frequency of the genes for this intolerance of lactose is very high in populations with no ancestral tradition of drinking fresh milk, and is low in populations traditionally drinking fresh milk, which suggests a post-agricultural evolutionary perspective. Indeed, it is very difficult to obtain milk from wild animals that are not domesticated!

Kretchmer (1993) and McMichael (2001) argue that the early movement of sheep, goat and (in due course) cattle pastoralism, migrating from the Middle East into Europe, accounts for the high European frequency of lactose tolerance. They go further and suggest that this also links in with the evolution of the lower susceptibility to type 2 diabetes in European populations compared to populations now undergoing the so-called 'Nutrition Transition' in other geographic areas, because the benefits of digesting lactose have a complex relationship to insulin release when needed (Allen and Cheer, 1996). On the other hand, Melnik (2009) has argued that milk consumption is responsible for other chronic 'Western' diseases. Gibson (2007) reviewed two genetic studies which also support the hypothesis of post-pastoral agricultural selection and evolution. On this topic of post-agrarian continuing evolution there is geographic diversity in susceptibility other conditions, such as type 1 diabetes, gluten intolerance, etc., but the reader should pursue this elsewhere.

Returning to the topic of the 'thrifty genotype' hypothesis, there is one scenario in which that explanation has been defended as logical. The Pacific Islands were inhabited by emigrants from Asia and New Guinea, who accomplished long journeys in open canoes. Any previous deposit of fat could have facilitated the survival of some individuals more than others in such wet conditions with limited food and cold nights. Now, for over fifty years, there has been a great quantity of medical literature on diabetes, obesity and related illnesses in the populations of these islands. However, the debates continue on how far the modern patterns of consumption and the so-called 'Western' foods have caused these medical conditions in these Pacific island populations and to what extent any 'thrifty' genotype explanation is valid and is operating under these modern dietary conditions.

Finally, the contemporary biological situation is even more complex than that since the arrival of agriculture, because with mechanisation of work and transport, people tend to expend less energy through physical exercise. Furthermore, as well as the carbohydrates and saturated fatty acids of traditional agriculture, today there is also the industrial processing of foods, with trans fatty acids, more sugar, more salt, the refining of many natural products, and various mixtures of artificial chemical substances, some of which have even been shown to be carcinogenic. To all of this, surely the human species has not had time to adapt through evolution.

6. CONCLUSION

Medical literature is full of alimentary causes for various illness, which suggest poor adaptation to our modern 'civilisation', and this maladaptation is discussed. However, in terms of adaptation, what is interesting is the irregular distribution, not only between populations but also within any population or society, of individuals who are affected by given conditions, and this must be due to human diversity, and in some considerable part due to human genetic diversity. It is therefore desirable that there should be greater understanding of the possible evolutionary origins of that genetic diversity.

The so-called 'nutritional transition' (Popkin and Gordon-Larsen, 2004) has now touched all societies and completely changed the nutrition of people in many populations (e.g. Hawkes, 2005; Siervo; et al., 2006), but there is diversity in the distribution of the illnesses viewed as resulting from this nutritional transition. For example, within the UK and its dietary and supermarket environment, in people of Indian descent there is a high frequency of ischaemic heart disease problems (Bhopal and Rafnsson, 2009), whereas in those of West Indian/Caribbean or African ancestry there is high blood pressure and high mortality from strokes (for a summary see Anand and Yusuf, 2001). The epidemiology of type 2 diabetes also shows diversity related to population ancestry (McMichael, 2001). Furthermore, the frequencies of the different cancers differ between different populations around the world (for a summary see Parkin, 2001), with many studies comparing cancer incidences in migrants and their donor and recipient

populations (e.g. Parkin and Khlat, 1996). The point to remember is that in all these ethnically defined 'populations' there exist people that do not suffer from these problems, nor from morbid obesity despite their modern diets. We can ask why there are these differences, if no population has had evolutionary time to adapt to modern patterns of nutrition. Surely, it is this aspect of the diversity and/or flexibility of human biology that is fascinating in the topic of globalisation, alimentation and human diversity, and deserves a great deal more research which is cross-disciplinary and holistic.

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